Supporting Info

rGO nickel matrix composites with high ozone degradation efficiency under high humidity

Qian Zhang[a, *], Wenyan Xiao[a, b], Bangxin Li[a, b], Yu Lin [a, b], Lingyu Huang[a, b], Jifei Liao[a, b], Huiguo Han[c], Jie Zhu[a, b] and Yan Fu[a, b]

Preparation of GO:

Preparation of graphene by first preparing the GO solution by HUMMER method[1] ,

The preparation steps are as follows:

1) Add 150 mL of concentrated sulfuric acid to a 500 mL flask, 50 mL of concentrated nitric acid. After the uniform mixing, while stirring while slowly adding 5 g of scaly graphite. After complete addition, stir with a stirrer for 24 h at room temperature;

2) Slowly add deionized water to the flask until almost full. Add the solution in the flask to the beaker, then add water slowly to about 2 L and cool for 24 h;

3) Using 0.22 μm microporous filter membrane for filtration. The filtered solid was washed three times with deionized water, get out. And dried in a 60℃ oven for 48 h;

4) Treated the crucible at 900℃ for 5 minutes. After cooling, place the dried solid evenly into eight crucibles, 1000℃ for 10s, and cooled with the furnace to obtain the expansion graphite.

5) The resulting expanded graphite was placed in a 500 mL flask, after adding 300 mL of concentrated sulfuric acid, 4.2 g $K_2S_2O_8$ and 6.2 g P_2O_5 were successively added to the flask and stirred at 80℃ for 5 h. After cooling to room temperature, slowly add sufficient deionized water to dilute and place for cooling;

6) It was again filtered using 0.22 μm microporous filter membrane and washed to neutral using deionized water, and the resulting solid was dried at room temperature for 2 d;

a. The Center of New Energy Materials and Technology, School of New Energy and Materials, Southwest Petroleum University, Chengdu 610500, P. R. China. E-mail: zhangqian@swpu.edu.cn

b. State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Southwest Petroleum University, Chengdu 610500, P. R. China.

c. State Key Laboratory of Vanadium and Titanium Comprehensive Utilization, Panzhihua 617000, Sichuan, China..

*Corresponding author: zhangqian@swpu.edu.cn (zhangqian)

Supporting Info

7) The dried solid was placed into a 500 mL flask with 200 mL of concentrated sulfuric acid and 15 g KMnO$_4$ slowly under stirring to control the reaction temperature not exceeding 15℃. After complete addition of KMnO$_4$, the temperature was raised to 35℃ for 2 h. Then slowly add deionized water to the flask is full, transfer the solution in the flask to the beaker, and then slowly add enough deionized water, place for cooling;

8) 10 mL of 30% hydrogen peroxide was stirred and left for 48 h, and the supernatant was removed;

9) Wash with 1.25 L of hydrochloric acid with a volume ratio of 1:10 and stand for 24 h before removing the supernatant;

10) Multiple times with 1 L of deionized water, washed, standing for 24 h before the supernatant was removed until solution pH appeared neutral, and the prepared GO solution was collected by centrifugation

11) The GO solution obtained from 1 mL was taken to freeze-drying and calibration.

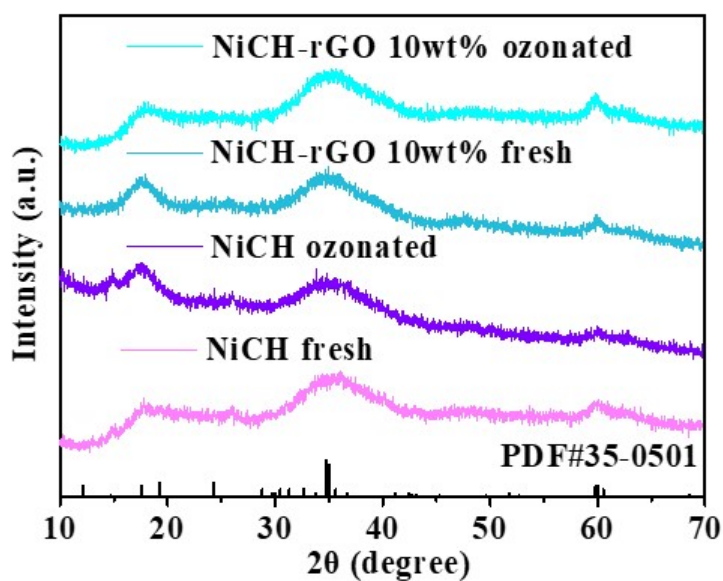The peak of NiCH-rGO 10wt% shows not much change after a 12 h reaction.

Figure. S1 XRD pattern of used NiCH and NiCH-rGO 10wt%.
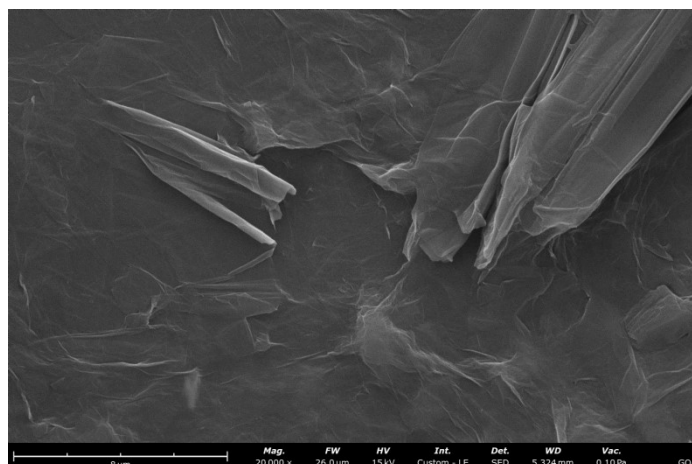
The SEM images of pure rGO

Supporting Info

Figure. S2 SEM image of pure rGO

The Raman spectra of NiCH, NiCH-rGO 10wt% and the samples after reaction with ozone. The gray line shows highest D and G peaks belongs to rGO.
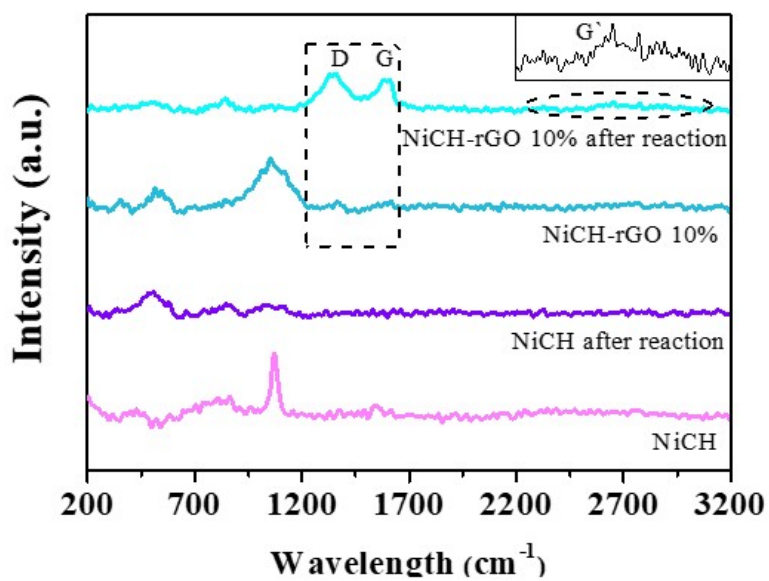

Figure. S3 Raman spectra of NiCH, NiCH-rGO 10wt%, and the samples after reaction with ozone.

Supporting Info

N 1s spectra of NiCH and NiCH-rGO 10% shows the same binding energy near 399.9 eV, which is the C-N bond of urea.
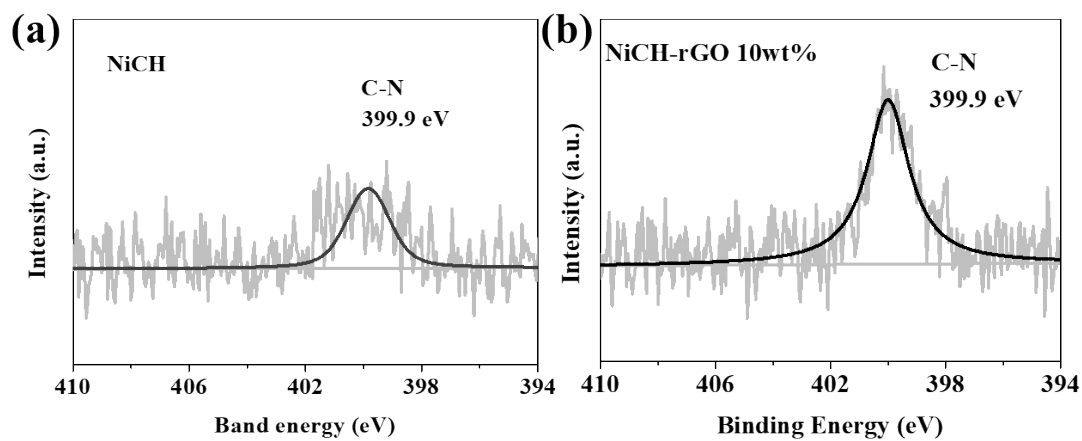

Figure. S4 N 1s in XPS of NiCH(a) and NiCH-rGO 10wt%(b).

Supporting Info

The AC impedance is shown in Figure. S4. The more rGO added into the NiCH samples the lower impedance NiCH-rGO shows, this property makes the electron transition from Ni atom to ozone compared with pure NiCH. The rGO composed of NiCH became the electronic conduction material and the reaction of ozone adsorption and decomposition was accelerated, which corresponds to the XPS data above.
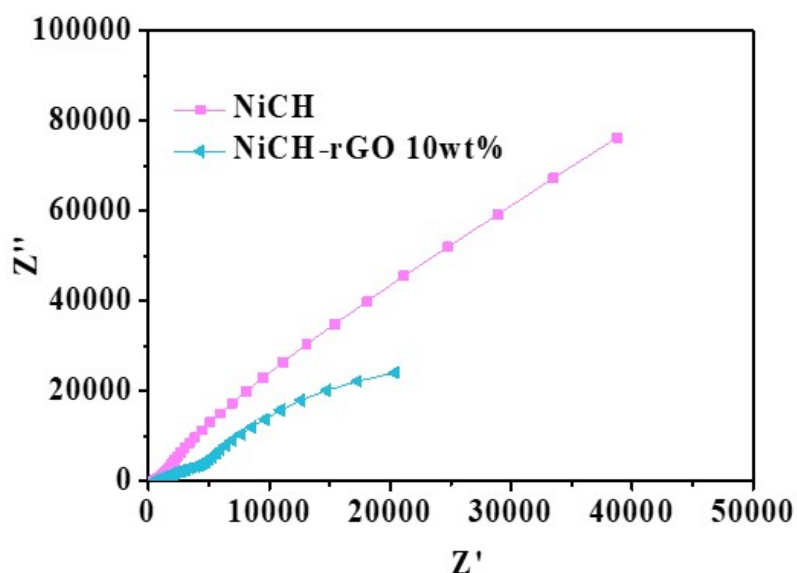

Figure. S5 AC impedance curve of NiCH, NiCH-rGO 5wt%, and NiCH-rGO 10wt%.

The vertical views (a, b) and the front views(c, d) of ozone adsorb structures on NiCH and NiCH-rGO.
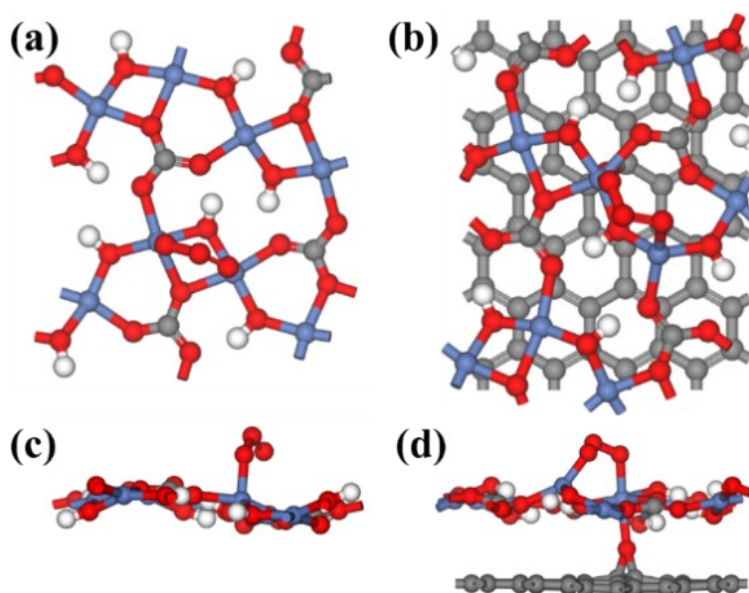

Figure. S6 The adsorption structures of ozone on NiCH(a, c) and NiCH-rGO(b, d).

Supporting Info

The charge transfer between the Ni atoms on the material surface and the ozone is analysed by theoretical calculation.
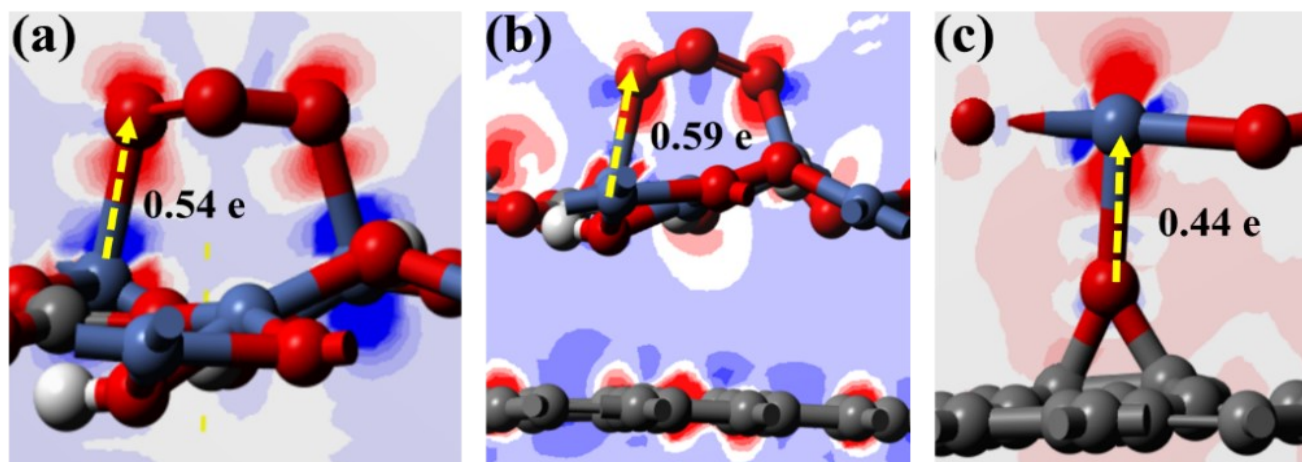

Figure. S7 The electron transferred from the oxygen atom of ozone to the Ni atom in (a)NiCH and (b)NiCH-rGO 10wt% and (c)inside the NiCH-rGO 10wt%.

The following figure shows the appearance of the catalyst and the UV-Vis spectrum data.
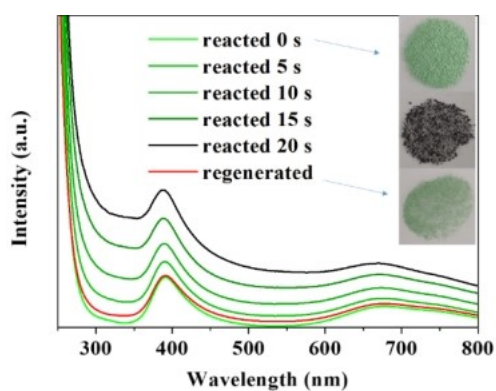

Figure. S8 UV-Vis Spectrophotometer of NiCH after ozone decomposition and regenerated by exposure to air.[2]

References

1. O. R. Jr W, *Journal of the American Chemical Society.*, 1958, **80**, 1339-1339.
2. Lin Yu, Xiao Wenyan, Li Bangxin, et al, Materials Reports, 2023, **37**: 22120067.